

THE PRODUCTION RATE OF COSMOGENIC 21-NE IN CHONDRITES DEDUCED FROM 81-KR MEASUREMENTS: L. Schultz and M. Freundel, Max-Planck-Institut für Chem. D-6500 Mainz, W. Germany.

Cosmogenic 21-Ne is used widely to calculate exposure ages of stone meteorites. In order to do so, the production rate $P(21)$ must be known. This rate, however, is dependent on the chemical composition of the meteorite as well as the mass of, and position within, the meteoroid during its exposure to the cosmic radiation. Even for a mean shielding the production rates determined from measurements of different radionuclides vary by a factor of two (e.g. [1]).

A method that can be used to determine exposure ages of meteorites that avoids shielding and chemical composition corrections is the 81-Kr-Kr-method [2,3]. However, for chondrites, in many cases, the direct determination of production rates for the Kr isotopes are prevented by the trapped gases and the neutron effects on bromine. Therefore, we have applied this method to four eucrite falls and then compared their 81-Kr-83-Kr-ages to their cosmogenic 21-Ne and 38-Ar concentrations.

The eucrites - Bouvante-le-Haut, Juvinas, Sioux County, and Stannern - were chosen for these measurements because their similar chemical composition regarding the major elements. The mean concentrations (in wt%) are: Mg-(4.1 ± .1); Al-(6.7 ± .5); Si-(22.8 ± .3); Ca-(7.52 ± .12); Fe+Ni (14.3 ± .3).

The Kr-exposure ages of the four eucrites are calculated from the measured isotopic composition of Kr. It is assumed that the trapped component has atmospheric isotopic composition and that the cosmogenic 83-Kr/86-Kr=0.015. Tab. 1 contains the 81-Kr exposure ages together with the cosmogenic 38-Ar concentrations. For all samples the correction for trapped 38-Ar is less than 1%. Fig. 1 shows the correlation between cosmogenic 38-Ar and 81-Kr exposure age of the four eucrites measured.

The production rate of 38-Ar in eucrites - $P(38)_E$ - is given by the slope of the line in Fig. 1. Considering the errors in both coordinates [4], this slope is calculated to be

$$P(38)_E = (0.139 \pm 0.005)10^{-8} \text{ccSTP/gMa}$$

This production rate is about 2% lower than recently published by us [5] due to the additional measurement of Stannern B. Both numbers agree within the uncertainties.

The given production rate $P(38)_E$ is a value which pertains to the mean shielding of the five samples. In the following it is assumed that this shielding is equivalent to the mean shielding of ordinary chondrites characterized by 22-Ne/21-Ne = 1.11. Using $P(38)_E$ and the measured 38-Ar/21-Ne - ratios the production rate $P(21)_E$ can be calculated. For the four investigated eucrites a mean value 38-Ar/21-Ne = 0.752 ± .041 is received. The resulting production rate is

$$P(21)_E = (0.185 \pm 0.013)10^{-8} \text{ccSTP/gMa.}$$

With the mean chemical concentration of Mg, Al, Si, S, Ca, Fe and Ni of eucrites and the following production rate ratios $P(21)_{\text{Mg}}/P(21)_{\text{Si}} = 5.15 \pm .3$; $P(21)_{\text{Mg}}/P(21)_{\text{S}} = 7.5 \pm 1.0$; $P(21)_{\text{Al}}/P(21)_{\text{Si}} = 1.9 \pm .6$;

$P(21)^{Ca}/P(21)^{Mg} = 0.04 \pm 0.04$; and $P(21)^{Fe,Ni} = (0.021 \pm 0.04)10^{-8} \text{ccSTP/gMa}$ an elemental production rate equation (in 10^{-8}ccSTP/gMa) is given by

$$P(21) = 1.63[Mg] + 0.6[Al] + 0.32[Si] + 0.22[S] + 0.07[Ca] + 0.021[Fe,Ni]$$

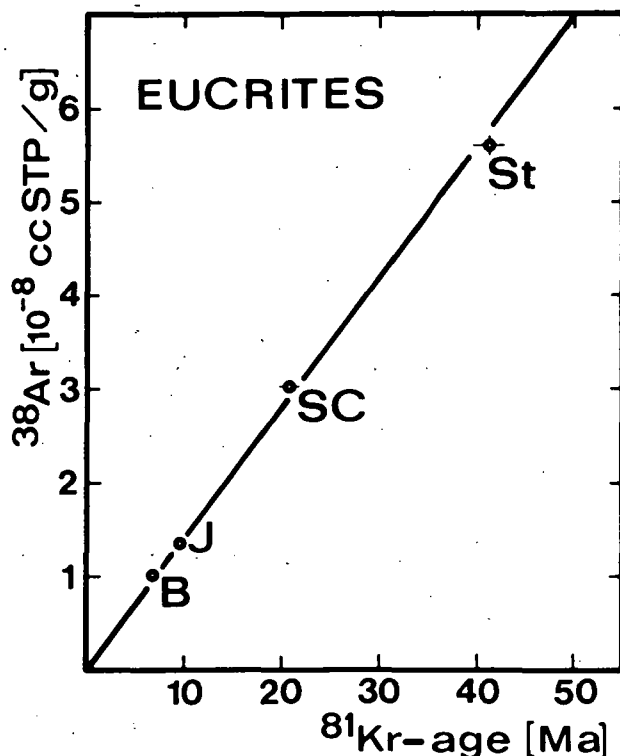
$\pm 0.18 \quad \pm 0.2 \quad \pm 0.04 \quad \pm 0.04 \quad \pm 0.07 \quad \pm 0.004$

([X] = concentration of element X as weight fraction).

From this equation a mean $P(21)_L$ is calculated for L-group chondrites using the chemical composition of the respective group [6]:

$$P(21)_L = (0.32 \pm 0.04)10^{-8} \text{ccSTP/gMa}$$

For H-group chondrites the production rate is 6% lower.



The major contribution to the production of 21-Ne in ordinary chondrites comes from Mg (about 76%) and Si (about 18%). The large uncertainties connected with the production rate ratios of the other elements are of less importance for $P(21)_L$.

The given value for $P(21)_L$ is within the limits of error in the range of recently determined production rates using other cosmogenic radionuclides [1,7,8] but 26-Al. This isotope tends to yield higher production rates for 21-Ne. This discrepancy may be caused by variations in the cosmic ray flux e.g. [1]. Also inadequate corrections for shielding and chemical composition variations cannot be ruled out [8].

Fig.1: Correlation of cosmogenic 38-Ar and the 81-Kr-exposure age of four eucrites. From the slope of the correlation line the production rate of 38-Ar is calculated.

| Meteorite | 38-Ar (10^{-8}cc/g) | 81-Kr-age (Ma) |
|--------------|---------------------------------|----------------------------------|
| Bouvante | 1.01 \pm 0.05 | 6.71 \pm 0.37 |
| Juvinas | 1.35 \pm 0.05 | 9.55 \pm 0.63 |
| Sioux County | 3.03 \pm 0.10 | 20.55 \pm 0.88 |
| Stannern A | 5.60 \pm 0.19 | 41.1 \pm 1.3 42.0 \pm 2.1 |
| Stannern B | 5.50 \pm 0.15 | 41.8 \pm 1.9 |

Tab. 1: Cosmogenic 38-Ar and 81-Kr-83-Kr-exposure ages of 4 eucrite falls.

References:

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